

# **Groundwater Quality and Well Water Assessment in Las Vegas New Mexico Area**

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## **Introduction**

The drinking water supplied to most northern New Mexicans usually meets the recommended standards of the State of New Mexico. However, there are often sporadic violations which must be detected early to prevent adverse health effects to consumers. The potential for such adverse health effects to the public makes water quality monitoring necessary. As such, the New Mexico Department of Environmental services and the New Mexico Department of Health are jointly investigating potential sources of contaminating pathogens and or chemicals and their association to drinking water.

Challenges to the quality of New Mexico's well water for domestic use include: limited water supplies and competing demands of industry, agriculture, and urban growth; unchecked installation of septic systems in areas of rapid growth; naturally occurring chemicals such as arsenic, uranium, and fluoride; and leaking underground storage tanks (New Mexico Environment Department's Source Water Assessment and Protection Program).

Preliminary surface water analysis indicates that water quality degrades at lower elevations in the Las Vegas area. This project is designed to investigate groundwater quality in selected wells of the Gallinas watershed. The project assumed that the selected wells would be representative of groundwater in the area and as such can be used to determine biological and chemical characteristics. Furthermore, a goal of this project is to determine if contaminants are reaching the water supply systems of households in the Gallinas watershed.

## **Study Area and Methods**

Most of the Gallinas watershed (84 sq. mi.) can be described as highly heterogeneous with outcroppings of fractured, igneous, sedimentary, or metamorphic rocks, some of which are at different stages of weathering. Precambrian igneous and metamorphic rocks dominate the higher elevations. Pennsylvanian and Cretaceous limestone becomes more abundant at mid and lower levels in the watershed. Cretaceous to Quaternary shale and clay dominated soils make up a majority of the lower watershed area (Figure 1).

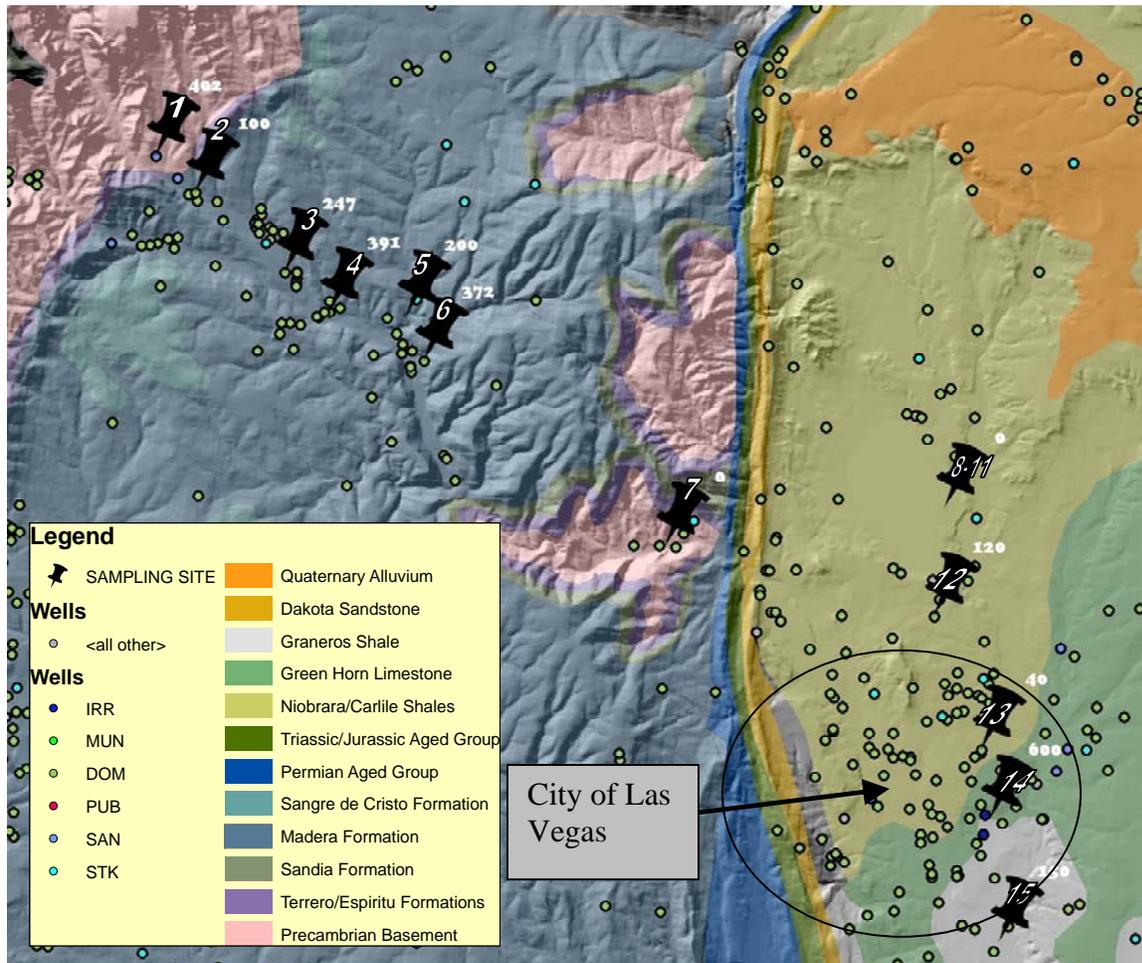


Figure 1. Sampling locations, wells, and surficial geology; white numerical values next to sites indicate well depth

The wells selected for the study represented groundwater supplies in the mountainous areas (7,000 to 8,600 feet) of the Gallinas watershed, areas west-northwest of the City of Las Vegas and in the alluvial areas within and near the city itself (6,300 to 7,000 feet). Wells were selected for their distribution in the watershed, depth, age of well, and contingent upon the permission of the private land owner. Wells older than 20 years were not sampled in this study. The intent of the study was to select wells with secure casings that would represent the groundwater from depth; not surface waters. Prior to collecting samples the water was allowed to flow from the tap for 10 minutes prior to filling acid washed and sterile bottles.

Sampling was conducted in May and November 2006. Groundwater was analyzed from 12 wells and one spring (Hot Springs near Montezuma, NM) for *E. coli*, nitrate, hardness, alkalinity, electrical conductivity and pH. *E. coli* was analyzed by EPA Method 1604. Nitrate + nitrite-N, hardness, alkalinity, electrical conductivity and pH were analyzed utilizing methods in Standard Methods for the Examination of Water and Wastewater (Clesceri, et al., 1998).

Normally distributed data were analyzed with one-way analysis of variance (AOV) and nonparametric data were analyzed using the Kruskal-Wallis one-way AOV to compare higher and lower elevation wells. The Spearman Rank Correlation was used for all correlation analyses.

Climate data were obtained from the USDA-NRCS Wesner Springs, NM Snotel site located in the Santa Fe Forest at 11,120 feet near the Gallinas watershed.

## Results

Precipitation varied greatly through the water year of October 1, 2005 to September 30, 2006 (Figure 2). The winter of 2005/2006 had an accumulated precipitation of approximately 5 inches. This is much less than the winter of 2005 which had an accumulated precipitation of approximately 25 inches. It remained dry through the spring 2006 with an accumulated precipitation of approximately 10 inches at the end of May 2006. The accumulated precipitation at the beginning of November 2006 was approximately 37 inches. Therefore, the second sampling represents a wetter period compared to the first sampling (Figure 2).

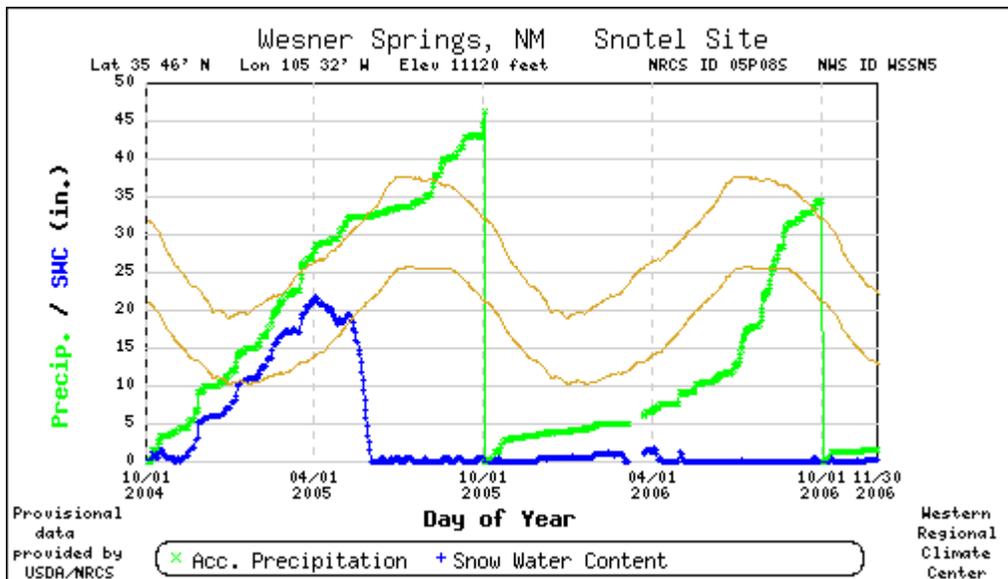


Figure 2. Snotel climate data for Wesner Springs, Oct. 2004 – Nov. 2006.

There was no significant trend ( $p = >0.05$ ) for nitrate + nitrite-N, hardness, alkalinity, pH, dissolved oxygen, total coliform and *E. coli* in groundwater from higher to lower elevations.

Electrical conductivity was greater at lower elevation than higher elevation ( $p = 0.014$ ) with mean values of 1300 and 289 uS/cm, respectively. Electrical conductivity ranged from 165 to 3050 uS/cm with an overall mean of 963 uS/cm. Mean pH for groundwater samples was 8.0 with a range of 7.1 to 8.8.

*E. coli* was positive in one well that is not used for human consumption. All other wells were negative for *E. coli*. However, 60% of the wells tested positive for total coliform bacteria.

Alkalinity and nitrate + nitrite-N increased from the May to the November sampling. Mean alkalinity increased from 254 to 407 mg/L (as CaCO<sub>3</sub>) ( $p = 0.045$ ) and ranged from 118 to 852 mg/L (as CaCO<sub>3</sub>). Mean nitrate + nitrite-N increased from 0.1 to 2.0 mg/L ( $p = 0.0005$ ) from May to November and ranged from 0.01 to 14.4 mg/L.

Significant positive correlations were observed for: alkalinity vs. conductivity ( $p = 0.048$ ), and hardness vs. conductivity ( $p = 0.0007$ ). Significant negative correlations were observed for: alkalinity vs. dissolved oxygen ( $p = 0.019$ ), hardness vs. pH ( $p = 0.0007$ ), hardness vs. well depth ( $p = 0.048$ ), and pH vs. conductivity ( $p = 0.0007$ ).

## Discussion and Conclusion

An increase in precipitation appeared to cause an increase alkalinity and nitrate + nitrite-N from May to November 2006. Increased precipitation during late summer and early fall 2006 may have lead to increased infiltration and percolation of surface water into the groundwater. One of the wells used for human consumption increased from 5.1 to 14.4 mg/L nitrate + nitrite-N. This was the only well that exceeded the drinking water standard of 10 mg/L nitrate + nitrite-N. The well located at a lower elevation in the alluvial area at a depth of 150 feet. The well may have been subject to infiltration/percolation or received surface water from runoff in the area. Additionally, there may be a problem with the well casing. The house wastewater system is connected to the City of Las Vegas sewer system. Therefore, human nitrate contamination can be ruled out. This area of Las Vegas contains numerous small grazing lots for horses fed with alfalfa and small open pastures. There may have been contamination to this well due to nitrates associated with these sources.

Greater electrical conductivity in the groundwater at lower elevations appears to also correlate with greater electrical conductivity in surface waters (Duran et al., 1998; Evans and Lindline, 2004; Evans et al., 2004; Johns-Kaysing and Lindline, 2006). Also, electrical conductivity correlates with hardness and alkalinity. This correlates positively with surface water studies in the lower watershed where calcium and sodium sulfates are dominate ions (Evans et al., 2004). It appears that groundwater exhibits similar trends to surface water regarding geochemistry.

*E. coli* does not appear to be a problem for drinking water supplies from the wells sampled in this study. However, wells were selected based on age to insure secure casings to prevent the input of surface waters to the wells.

Oxygen was difficult to analyze given the field conditions at the various sites. As such, a method to determine redox potential may be more informative and represent conditions at depth in the wells. Some of the wells sampled had very distinct odors of reduced sulfide (i.e. rotten eggs). Therefore, an onsite test for sulfide is recommended to indicate redox conditions at depth.

Well chemical characteristics change with season, climate conditions, elevation and depth. There are no serious public health concerns with the majority of the wells sampled. In unexpected cases, however, a small percentage of wells may have a problem with either bacteria or nitrates. It is our recommendation that individual households take the responsibility to have their water tested at least twice in one year, making sure that one of the samples is collected and analyzed either during a wet period or immediately following a wet period.

## Acknowledgements

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